

1 We claim:

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3 1) A slow wave structure for a traveling wave tube,
4 said structure having:

5 a beam tunnel having an axis, a beam entrance and a
6 beam exit;

7 a substrate including a plurality of elongate pins,
8 each said pin having an attachment end and a beam tunnel
9 end, said pins perpendicular to said substrate and said beam
10 tunnel end of said pins located in said beam tunnel, said
11 substrate including an exit aperture perpendicular to said
12 beam tunnel, said elongate pin beam tunnel ends forming a
13 substantially planar surface, said elongate pins having a
14 first depth along said beam tunnel from said beam exit to a
15 first distance from said exit aperture, and a second depth
16 from said first distance to said beam entrance.

17

18 2) The slow wave structure of claim 1 where said beam
19 tunnel carries an electron beam.

20

21 3) The slow wave structure of claim 1 where said beam
22 tunnel carries electromagnetic waves having a wavelength.

23

24 4) The slow wave structure of claim 3 where said first
25 distance is half said wavelength.

1

2 5) The slow wave structure of claim 3 where said first
3 distance is $(n+1)/2$ said wavelengths, where n is an integer
4 greater than 0.

5

6 6) The slow wave structure of claim 3 where said
7 elongate pins have a pitch less than 0.1 said wavelengths.

8

9 7) The slow wave structure of claim 1 where said output
10 port is an aperture perpendicular to said beam tunnel.

11

12 8) The slow wave structure of claim 1 where said pins
13 are arranged in rows perpendicular to said beam tunnel axis.

14

15 9) The slow wave structure of claim 1 where said pins
16 are arranged in columns parallel to said beam tunnel axis.

17

18 10) The slow wave structure of claim 1 where said pins
19 are arranged in rows and columns, said slow wave structure
20 includes a longitudinal gap equal to one or more said
21 columns, and said exit aperture is centered in said gap.

22

23 11) The slow wave structure of claim 1, said structure
24 including a beam shaper having slots aligned with gaps
25 between said pins, said beam shaper having a surface

1 substantially planar with said elongate pins beam tunnel
2 ends.

3

4 12) A slow wave structure for a traveling wave tube,
5 said structure supporting a plurality of wavelengths and
6 having:

7 a beam tunnel having an axis, a beam entrance and a
8 beam exit;

9 a substrate including:

10 a plurality of elongate pins, each said pin having an
11 attachment end and a beam tunnel end, said elongate pins
12 perpendicular to said substrate and said pin beam tunnel
13 ends substantially co-planar with said beam tunnel axis;
14 an exit aperture perpendicular to said beam tunnel;
15 said elongate pins having a plurality of step change
16 depths, each step change depth occurring a unique distance
17 from said exit aperture.

18

19 13) The slow wave structure of claim 12 where said beam
20 tunnel carries an electron beam.

21

22 14) The slow wave structure of claim 12 where said beam
23 tunnel carries electromagnetic waves having at least one
24 wavelength.

25

1 15) The slow wave structure of claim 14 where the
2 distance between said step change depth and said exit
3 aperture is half said wavelength.
4

5 16) The slow wave structure of claim 14 where the
6 distance between said step change depth and said exit
7 aperture is $(n+1)/2$ said wavelengths, where n is an integer
8 greater than 0.
9

10 17) The slow wave structure of claim 14 where said
11 elongate pins have a pitch less than 0.1 said wavelength.
12

13 18) The slow wave structure of claim 14 where said
14 output port is an aperture perpendicular to said beam
15 tunnel.
16

17 19) The slow wave structure of claim 14 where said pins
18 are arranged in rows perpendicular to said beam tunnel axis.
19

20 20) The slow wave structure of claim 14 where said pins
21 are arranged in columns parallel to said beam tunnel axis.
22

23 21) The slow wave structure of claim 14 where said pins
24 are arranged in rows and columns, said slow wave structure

1 includes a longitudinal gap equal to one or more said
2 columns, and said exit aperture is centered in said gap.

3
4 22) An oscillator for radio frequency (RF) waves, said
5 oscillator having:

6 a beam tunnel formed from a substrate, said beam tunnel
7 having a plurality of elongate pins, said pins having one
8 end connected to said substrate and an opposing beam tunnel
9 end, said elongate pin beam tunnel ends substantially co-
10 planar, said beam tunnel having, in sequence:

11 a beam tunnel entrance receiving electrons from a
12 thermionic cathode;

13 a beam tunnel reflection end having a plurality of said
14 elongate pins, said beam tunnel reflection end having one or
15 more reflection regions whereby said elongate pins change
16 depth;

17 a beam tunnel half wave section with said elongate pins
18 having said first depth;

19 a beam tunnel exit aperture formed by a gap in said
20 elongate pins;

21
22 a beam tunnel gain section with said elongate pins
23 having a first depth;

1 a beam tunnel exit coupling said electrons to a
2 collector;

3 said oscillator coupling energy to said exit aperture.
4

5 23) The oscillator of claim 22 where said beam tunnel
6 entrance includes an electron beam shaper having a surface
7 substantially co-planar with said elongate pin beam tunnel
8 ends.
9

10 24) The oscillator of claim 23 where said beam shaper
11 includes slots parallel to said beam tunnel axis.
12

13 25) The oscillator of claim 22 where said beam tunnel
14 carries an electron beam.
15

16 26) The oscillator of claim 22 where said beam tunnel
17 carries electromagnetic waves having a wavelength.
18

19 27) The oscillator of claim 26 where the distance from
20 said reflection region said pin depth change to said exit
21 aperture is half said wavelength.
22

23 28) The oscillator of claim 26 where the distance from
24 said reflection region said pin depth change to said exit

1 aperture is $(n+1)/2$ said wavelengths, where n is an integer
2 greater than 0.

3

4 29) The oscillator of claim 26 where said elongate pins
5 have a pitch less than 0.1 said wavelengths.

6

7 30) The oscillator of claim 22 where said output port
8 is an aperture perpendicular to said beam tunnel.

9

10 31) The oscillator of claim 22 where said pins are
11 arranged in rows perpendicular to said beam tunnel axis.

12

13 32) The oscillator of claim 22 where said pins are
14 arranged in columns parallel to said beam tunnel axis.

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16 33) The oscillator of claim 22 where said pins are
17 arranged in rows and columns, said oscillator includes a
18 longitudinal gap equal to one or more said columns, and said
19 exit aperture is centered in said gap.

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21 34) The oscillator of claim 22, said reflection region
22 comprising a plurality of pin depths having a plurality of
23 said pin depth changes, each said pin depth change being
24 $(n+1)/2$ wavelengths from said exit aperture, where n is an
25 integer greater than 0.

1
2 35) An amplifier for radio frequency (RF) waves, said
3 amplifier having:
4 a beam tunnel formed from a substrate, said beam tunnel
5 having a plurality of elongate pins, said pins having one
6 pin end connected to said substrate and an opposing beam
7 tunnel pin end, said elongate pin beam tunnel pin ends
8 substantially co-planar, said beam tunnel having, in
9 sequence:
10 a beam tunnel entrance receiving electrons from a
11 thermionic cathode;
12 a beam tunnel input reflection section, said elongate
13 pins having one or more first depths;
14 a beam tunnel input half wave section with said
15 elongate pins having a second depth;
16 a beam tunnel input aperture formed by a gap in said
17 elongate pins having said second depth;
18 a beam tunnel wave section with said elongate pins
19 having said second depth;
20 a beam tunnel exit aperture formed by a gap in said
21 elongate pins having said second depth;
22 a beam tunnel half wave section with said elongate pins
23 having said second depth;
24 a beam tunnel reflection end having a plurality of said
25 elongate pins, said beam tunnel reflection end having one or

1 more reflection regions whereby said elongate pins change
2 said depth;

3 a beam tunnel exit coupling said electrons to a
4 collector.

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6 36) The amplifier of claim 35 where said beam tunnel
7 entrance includes an electron beam shaper having a surface
8 substantially co-planar with said elongate pin beam tunnel
9 ends.

10

11 37) The amplifier of claim 35 where said beam shaper
12 includes slots parallel to said beam tunnel axis.

13

14 38) The amplifier of claim 35 where said beam tunnel
15 carries an electron beam.

16

17 39) The amplifier of claim 35 where said beam tunnel
18 carries electromagnetic waves having one or more
19 wavelengths.

20

21 40) The amplifier of claim 35 where said beam tunnel
22 carries electromagnetic waves having a plurality of
23 wavelengths, and said input reflections section includes a
24 plurality of said pin said first depths which have an

1 associated F_{maximum} which exceeds at least one of said
2 wavelengths.

3

4 41) The amplifier of claim 40 where the separation
5 between said input aperture and the change from said second
6 depth to said one or more first depths is $(n+1)/2$ said
7 wavelengths for at least one said wavelength, where n is an
8 integer greater than 0.

9

10 42) The amplifier of claim 39 where said elongate pins
11 have a pitch less than 0.1 of at least one of said
12 wavelengths.

13

14 43) The amplifier of claim 35 where at least one of
15 said input aperture or said output aperture is an aperture
16 perpendicular to said beam tunnel.

17

18 44) The amplifier of claim 35 where said pins are
19 arranged in rows perpendicular to said beam tunnel axis.

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21 45) The amplifier of claim 35 where said pins are
22 arranged in columns parallel to said beam tunnel axis.

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24 46) The amplifier of claim 35 where said pins are
25 arranged in rows and columns which include a longitudinal

1 gap equal to one or more said columns, and said exit
2 aperture is centered in said gap.

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4 47) The amplifier of claim 35, including a beam shaper
5 having slots aligned with gaps between said pins, said beam
6 shaper having a surface substantially planar with said
7 elongate pins beam tunnel ends.

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